FORMAT INSTRUMEN PEPERIKSAAN SPM MULAI TAHUN 2021
MATA PELAJARAN FIZIK (4531)/ KIMIA (4541)/ BIOLOGI (4551)/ SAINS TAMBAHAN (4561)

BIL	PERKARA	KERTAS 1 (4531/1)/(4541/1)/(4551/1)/(4561/1)	KERTAS 2 (4531/2)/(4541/2)/(4551/2)/(4561/2)	KERTAS 3 (4531/3)/(4541/3)/(4551/3)/(4561/3)
1	**Jenis Instrumen**	Ujian Bertulis		Ujian Amali
2	**Jenis Item**	Objektif Aneka Pilihan	• Subjektif Berstruktur • Subjektif Respons Terhad • Subjektif Respons Terbuka	Tugasan Amali Berpandu dan Tidak Berpandu
3	**Bilangan Soalan**	40 soalan (40 markah) (Jawab **semua** soalan)	**Bahagian A:** • 8 soalan (60 Markah) (Jawab **semua** soalan) **Bahagian B:** (20 Markah) • 2 soalan (Jawab **1** soalan) **Bahagian C:** (20 Markah) • 1 soalan	2 Tugasan Amali
4	**Jumlah Markah**	**40 markah**	**100 markah**	**30 markah**
5	**Konstruk**	• Mengingat • Memahami • Mengaplikasi • Menganalisis	• Mengingat • Memahami • Mengaplikasi • Menganalisis • Menilai • Mencipta	• Mengingat, Memahami, Mengaplikasi / Mencipta • Kemahiran proses sains • Kemahiran manipulatif
6	**Tempoh Ujian**	1 jam 15 minit	2 jam 30 minit	1 jam 45 minit
7	**Cakupan Konteks**	Standard kandungan dan standard pembelajaran dalam Dokumen Standard Kurikulum dan Pentaksiran (DSKP) KSSM (Tingkatan 4 dan 5)		
8	**Aras Kesukaran**	Rendah : Sederhana : Tinggi 5 : 3 : 2		
9	**Kaedah Penskoran**	Dikotomus	Analitik	
10	**Alat Tambahan**	Kalkulator saintifik		

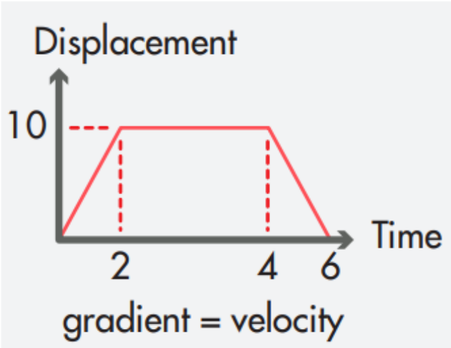
Siri 1 - Force & motion (graph)
Gravitation
Heat
Light - lens & mirror

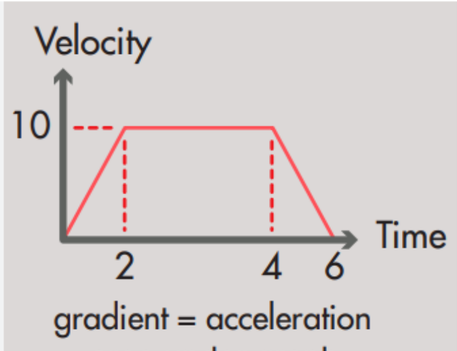
Siri 2 - electricity
Electromagnet
Electronics
Nuclear physics

Siri 3: Force motion 2
Pressure
Waves
Quantum Physics

SCALAR	VECTOR
Distance, d How far body travel in motion **5m**	Displacement, s shortest path from starting point to end point -5m left ⟵ ⟶ +5m right

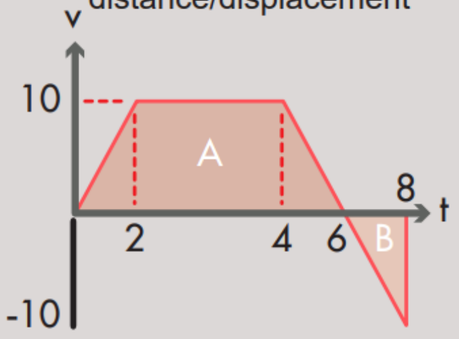
SPEED	VELOCITY
Rate of change of distance $\frac{\text{Distance}}{\text{Time}} = \frac{m}{s} = ms^{-1}$	Rate of change of displacement $\frac{\text{Displacement}}{\text{Time}} = \frac{m}{s} = ms^{-1}$
A — 5m — B t = 1s	A — 5m — B t = 1s
$V_{AB} = 5ms^{-1}$ $V_{BA} = 5ms^{-1}$	$V_{AB} = 5ms^{-1}$ (right) $V_{BA} = -5ms^{-1}$ (left)





Distance
Area A + Area B

Displacement
Area A - Area B



ACCELERATION, a

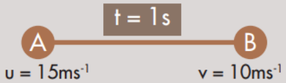
Rate of change of velocity

$a = \frac{v - u}{t} = \frac{ms^{-1}}{s} = ms^{-2}$

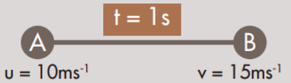
Uniform a,

$v^2 = u^2 + 2as$

$s = ut + \frac{1}{2}at^2$

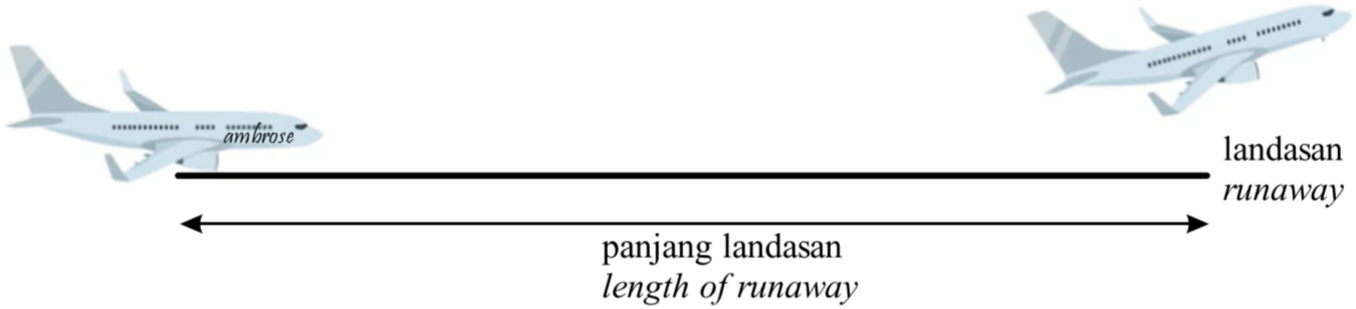


$a_{AB} = \frac{10 - 15}{1} = -5ms^{-2}$



$a_{AB} = \frac{15 - 10}{1} = 5ms^{-2}$

5. Rajah 4 menunjukkan sebuah kapal terbang sedang berlepas.
Diagram 4 shows an aeroplane is take off.



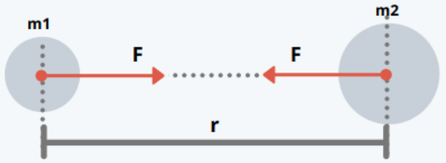
Rajah / *Diagram* 4

Berapakah panjang landasan bagi sebuah kapal terbang untuk berlepas dengan halaju 75 m s^{-1} jika ia boleh memecut 2.0 m s^{-2}?
How long must a runaway be for an aeroplane to reach take off velocity 75 m s^{-1} if it can accelerate 2.0 m s^{-2}?

A. 1 000 m
B. 1 200 m
C. 1 400 m
D. 2 000 m

GRAVITATION

GRAVITATIONAL FORCE



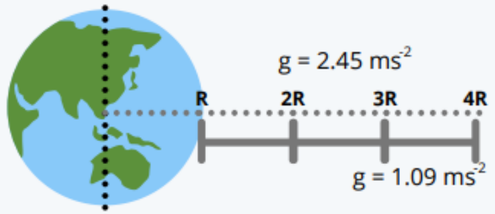
$$F = \frac{G\, m_1 m_2}{r^2}$$

F = Gravitational force between two bodies
m1 = mass of first body
m2= mass of second body
r = distance between the centre of first body and the centre of the second body.
G = Gravitational constant **6.67×10^{-11} N m^2 kg^{-2}**

product of mass ↑ Gravitational force,F ↑
Distance between the centres, r ↓ Gravitational force F ↑

#magnitude of force between the two bodies is same

RELATIONSHIP g & G

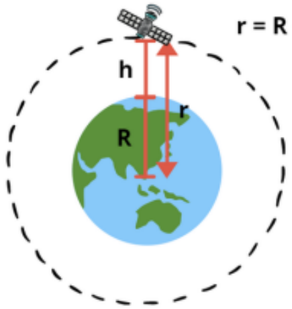


at surface of Earth

$$g = \frac{G\, M}{R^2}$$

$g = 9.81\ ms^{-2}$

g= Gravitational acceleration
M = mass Earth--5.97 x 10^{24} kg
R = Radius Earth-- 6.37 x 10^{6} m
G = Gravitational constant
6.67 x 10^{-11} N m^2 kg^{-2}

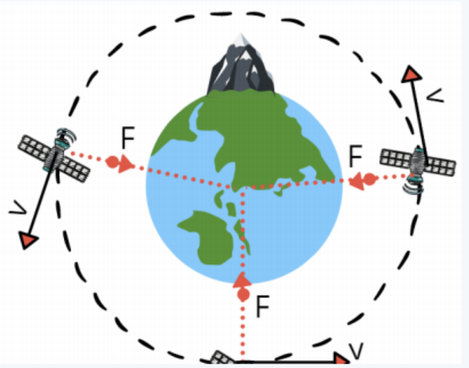


At height,h from surface of the Earth

$$g = \frac{G\, M}{(R+h)^2}$$

when value **h** increase ↑
value **g** will decrease ↓

CENTRIPETAL FORCE,F
CENTRIPETAL ACCELERATION,a



$$a = \frac{v^2}{r}$$

$$F = \frac{mv^2}{r}$$

a = Centripetal acceleration
v = Linear speed of satelite
r = radius of the orbit

F = Centripetal force
m =mass
v = Laju speed
r = radius of circle

v ↑ circulating earth, Gravitational force acting toward the earth acts as centripetal force.

v ↓ will fall back to earth

Sebuah satelit pengimejan radar mengorbit mengelilingi bumi pada ketinggian 500 km. Berapakah nilai pecutan graviti satelit di kedudukan tersebut?

A radar imaging satellite orbits around the earth at a height 500 km. what is the value of gravitational acceleration at the position of the satellite?

[$G = 6.67 \times 10^{-11}\ Nm^2 kg^{-2}$, $R = 6.37 \times 10^{6}\ m$, $M = 5.97 \times 10^{24}\ kg$]

A. 9.81 m s^{-2}

B. 9.50 m s^{-2}

C. 8.15 m s^{-2}

D. 8.44 m s^{-2}

KEPLER'S LAWS

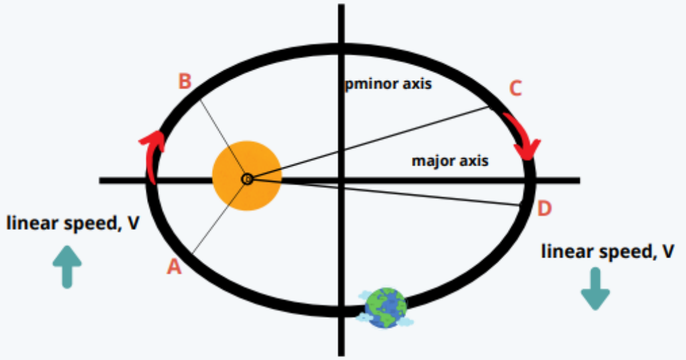
Kepler's First law

All planets move in **elliptical orbits** with the **sun** at one focus (Law of Orbit)

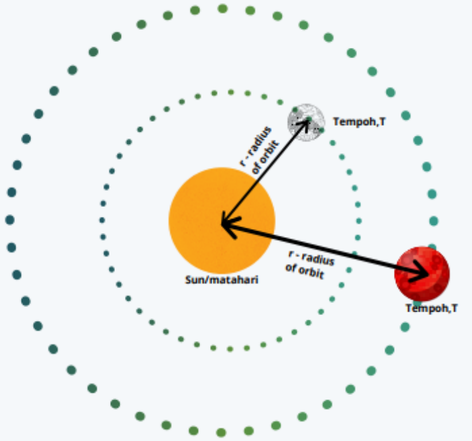
#Orbits looks **almost round** because length of major axis and minor axis almost same length

Kepler's Second Law

A line that connects a planets to the Sun sweeps out **equal areas** in **equal time** (Law of Area)



Area region AB = Area region CD
time to move from AB = time to move from CD

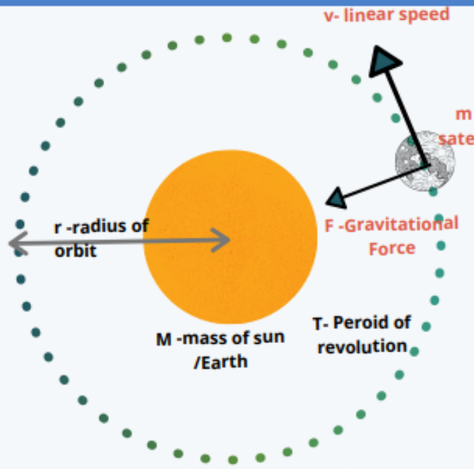


Kepler's third law

square of orbital period is directly proportional to **the cube of the radius of its orbit**

$$T^2 = \left(\frac{4\pi^2}{GM}\right) r^3 \qquad \frac{T_1^2}{T_2^2} = \frac{r_1^3}{r_2^3}$$

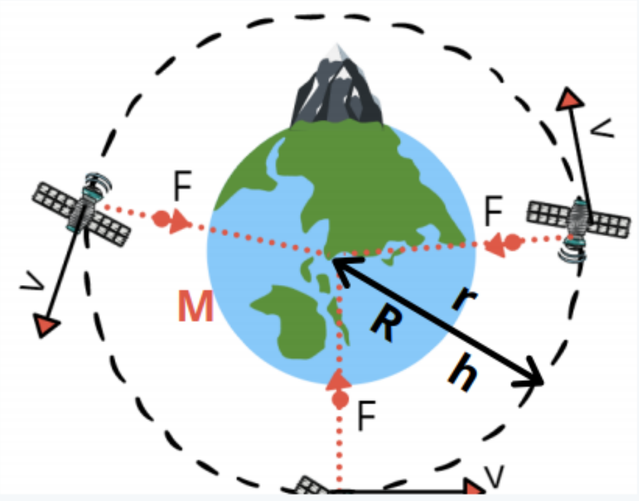
MEASURE MASS EARTH OR SUN



$$M = \frac{4\pi^2 r^3}{GT^2}$$

M = Mass of Sun/ Earth
r = radius of orbit satelite/ moon
T =Period of revolution satelite/ moon /planet
G = Gravitational constant $6.67 \times 10^{-11}\ N\ m^2\ kg^{-2}$

LINEAR SPEED OF SATELLITE



$$v = \sqrt{\frac{GM}{r}} \qquad v = \sqrt{\frac{GM}{R+h}}$$

v = linear speed of satellite

r = radius of orbit of satellite

the linear speed is high enough for the satellite to move in circular orbit around Earth

GEOSTATIONARY

- Direction of motion is same as Earth rotation
- T = 24 hours
- same geographical location
- Communication satellite (MEASAT)

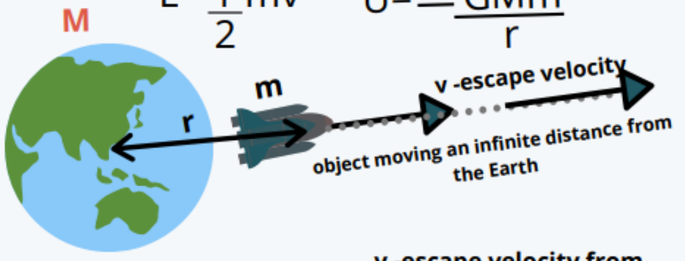
NON GEOSTATIONARY

- need not be the same with direction of earth rotation.
- T= < 24 hours / > 24 hours
- Above different geographical location
- Earth imaging, GPS, weather forcast (ISS, TiungSAT,RazakSAT)

ESCAPE VELOCITY

Achieved when **minimum kinetic energy able to overcome the gravitational potential energy**

$$E = \frac{1}{2}mv^2 \qquad U = -\frac{GMm}{r}$$



$$v = \sqrt{\frac{2GM}{r}}$$

v -escape velocity from earth(mass of earth is large)

v = 11 200 ms^{-1}

Sebuah satelit buatan manusia mengorbit mengelilingi Bumi pada ketinggian 1620 km. Berapakah laju linear satelit itu?

[Jisim Bumi $= 5.97 \times 10^{24}\ kg$, jejari Bumi $= 6.37 \times 10^{6}\ m$, $G = 6.67 \times 10^{-11}\ N\ m^2\ kg^{-2}$]

A man-made satellite orbits around the Earth at a height of 1620 km. What is the linear speed of the satellite?

[Mass of the Earth $= 5.97 \times 10^{24}\ kg$ *, radius of the Earth* $= 6.37 \times 10^{6}\ m$ *]*

A $7.06 \times 10^{3}\ m\ s^{-1}$

B $15 \times 10^{3}\ m\ s^{-1}$

C $22.2 \times 10^{3}\ m\ s^{-1}$

D $1.0 \times 10^{4}\ m\ s^{-1}$

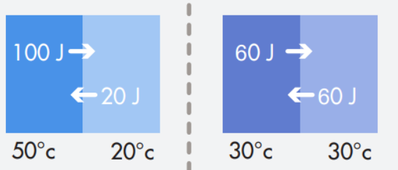
HEAT, Q

Temperature	Heat, Q
Degree of hotness	Thermal energy tranfer due to different in temperature
Kelvin, K	
(°c, F)	Joule, J

°c → Kelvin, K

θ°c = (θ + 273) K

THERMAL EQUILIBRIUM

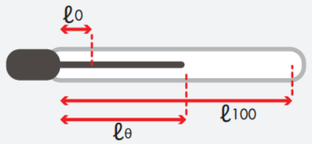


Heat transfer in thermal contact

Thermal equilibrium
#same temperature; net heat transfer = 0
same heat transfer

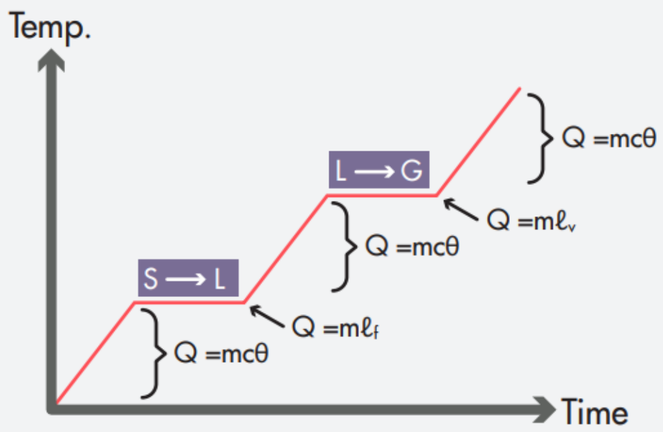
Thermometer

Use concept of thermal equilibrium



$$\text{Temp, } \theta = \frac{\ell_\theta - \ell_0}{\ell_{100} - \ell_0} \times 100°c$$

mercury? < sensitive to temperature change; heat uniformly/non-sticky



What is quantity of heat required to change 2kg of water from 20°c to 30°c?
Temperature change. Specific heat capacity, Q=mcθ

What is quantity of heat released to change 2kg of water at 0°c to ice at 0°c?
Water to ice (liquid → solid). Latent heat, Q=mℓ

What is quantity of heat required to change 2kg of ice at 0°c to water at 30°c?
State change (solid → liquid), temperature change:
$Q_1 = mc\theta$
$Q_2 = m\ell$
$Q_T = Q_1 + Q_2$

SPECIFIC HEAT CAPACITY, C

The amount of heat/energy required by 1kg substance to:

change it temperature by 1°c without changing state

$$Q = mc\theta$$

$$\text{heat (energy)} = (\text{mass})(\text{specific heat capacity})(\text{temp. change})$$

$$J = kg(Jkg^{-1}°c^{-1})(°c)$$

Low c = easily heatup/cooldown

High c = hardly heatup/cooldown
store more energy

Q is heat (energy)
if using immersion heater (electric)

$$Pt = mc\theta$$

$$Pt = m\ell$$

LATENT HEAT, ℓ (SPECIFIC)

change it state from _____ to _____ at constant temperature

$$Q = m\ell$$

$$\text{heat (energy)} = (\text{mass})(\text{latent heat})$$

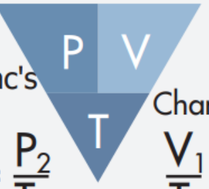
$$J = kg(Jkg^{-1})$$

What is quantity of heat required to change 2kg of water from 20°c to 30°c?
Temperature change. Specific heat capacity, Q=mcθ

GAS LAW

Boyle's Law

$P_1V_1 = P_2V_2$



Gay-Lussac's law

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Charles' Law

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Boyle's Law

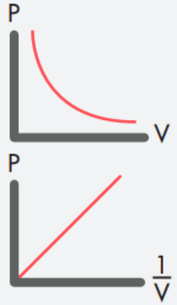
Fix mass and temp. of gas (constant temp) pressure,P of gas inversely proportional with volume,V

$P \propto \frac{1}{V}$

$P = \frac{k}{V}$

$PV = k$ (constant)

$P_1V_1 = P_2V_2$



Gay-Lussac's

mass and V constant, P directly proportional with T

$P \propto T$

$P = kT$

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Charles'

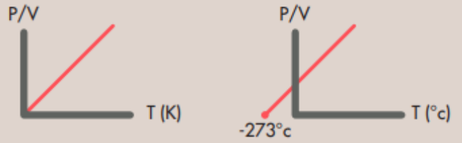
mass and P constant, V directly proportional with T

$V \propto T$

$V = kT$

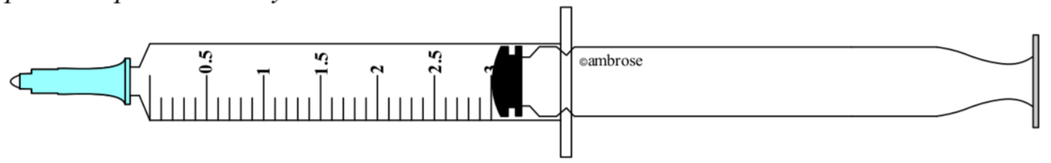
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

temp. must change to KELVIN!

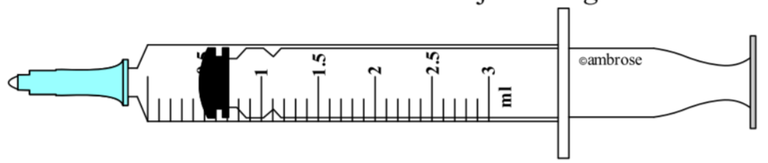


- Determine which law
- Kinetic theory of gas (paper 2)
- dont forget to change unit for temperature from 'C to K

Rajah 12.1 dan Rajah 12.2 menunjukkan dua picagari yang serupa dengan muncungnya ditutup. Apabila isipadu udara terperangkap dalam picagari adalah 3 ml, tekanannya adalah $1\times10^5\ Pa$. Kemudian omboh ditolak perlahan-lahan sehingga isipadunya 0.45 ml.
Diagram 12.1 and Diagram 12.2 shows two identical syringes with their nozzles closed. When the volume of air trapped in the syringe is 3 ml, the pressure is $1\times10^5\ Pa$ *. Then the piston is pushed slowly until its volume is 0.45 ml.*



Rajah / *Diagram* 12.1



Rajah / *Diagram* 12.2

Berapakah tekanan udara yang terperangkap?
What is the pressure of trapped air?

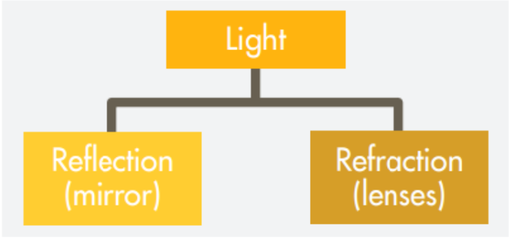
A. $8.0\times10^5\ Pa$
B. $7.67\times10^5\ Pa$
C. $5.67\times10^5\ Pa$
D. $6.67\times10^5\ Pa$

Sebiji bola ping pong yang kemek mempunyai isipadu 30 cm^3 telah mengembang kepada 38 cm^3 setelah dimasukkan ke dalam air panas bersuhu 100 °C.
A dented ping pong ball has volume 30 cm^3 is inflated to 38 cm^3 in a hot water of temperature 100 °C.

Berapakah suhu awal udara dalam bola ping pong?
What is the initial temperature of the air inside the ping pong ball?

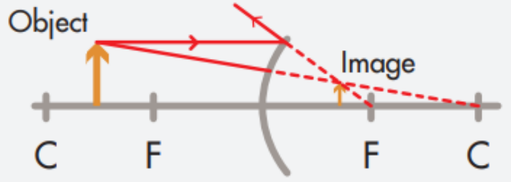
A 21.47°C
B 25.00°C
C 34.21°C
D 38.95°C

- Determine which law
- Kinetic theory of gas (paper 2)
- dont forget to change unit for temperature from 'C to K



Convex mirror = Concave lens

Image DO NOT depend on position of the object
1. Virtual 2. Upright 3. Diminish

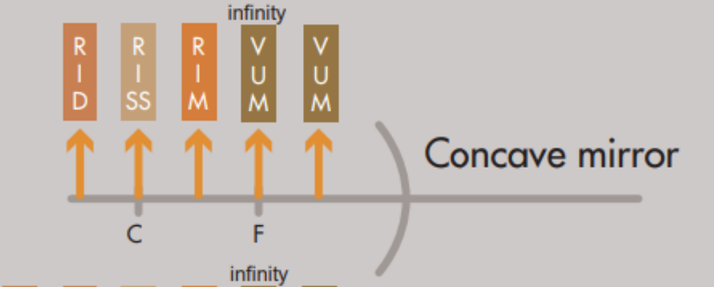


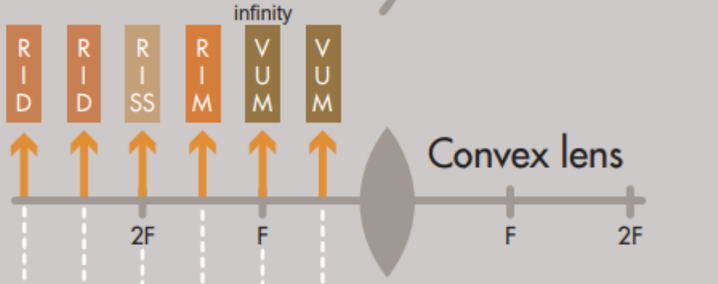
Convex mirror

give wider view
(at store, corner of road)

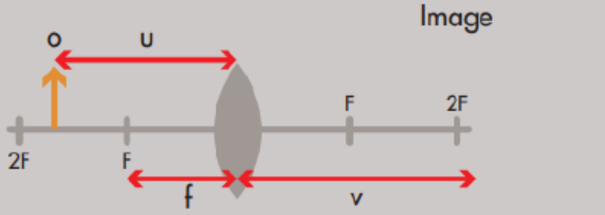
Concave mirror = Convex lens

Image DEPEND on position of the object





Objective lens telescope | Camera | Photocopy machine | Projector/ Microscope | Eyepiece telecope | Magnifying glass



u = object distance | v = image distance | f = focal length

$$\text{Power, } P = \frac{100}{f} \text{ (in cm)}$$

Diopter, D

P ▲ f ▼

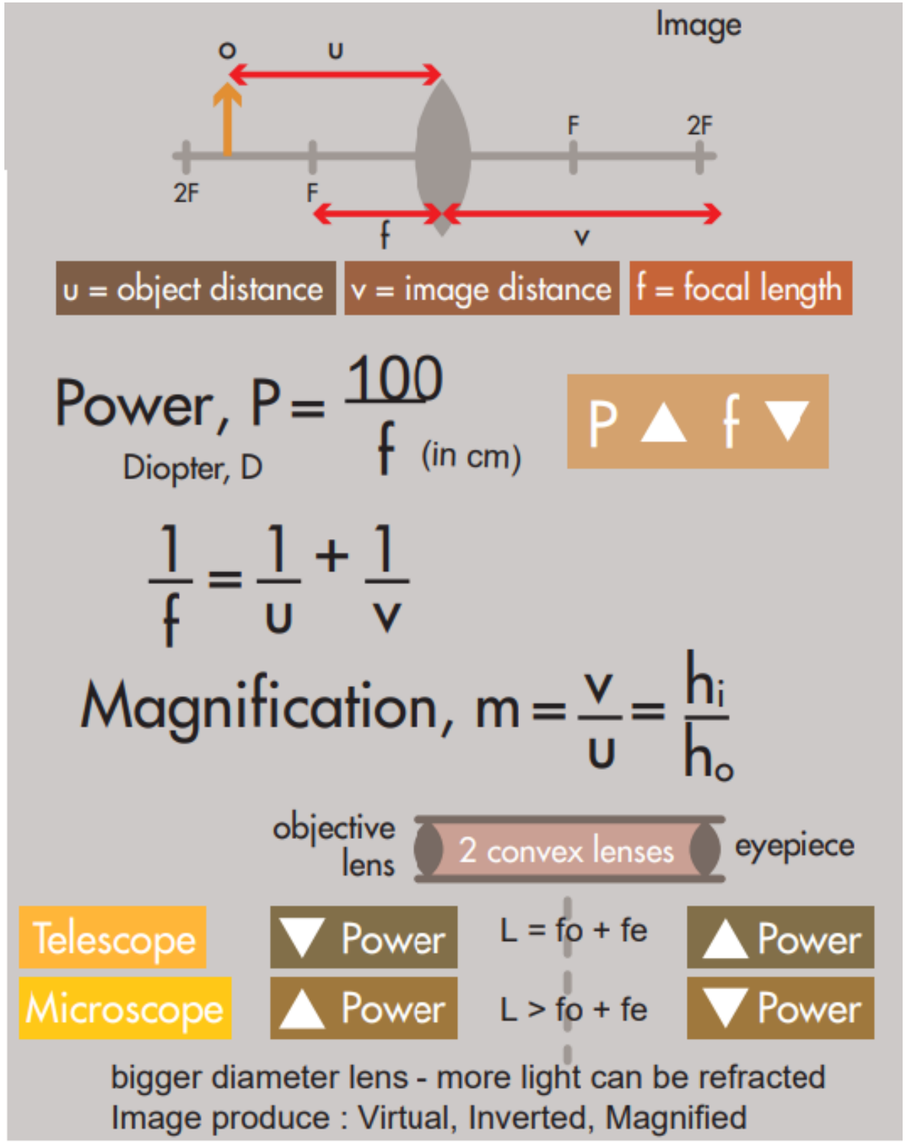
$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\text{Magnification, } m = \frac{v}{u} = \frac{h_i}{h_o}$$

objective lens — 2 convex lenses — eyepiece

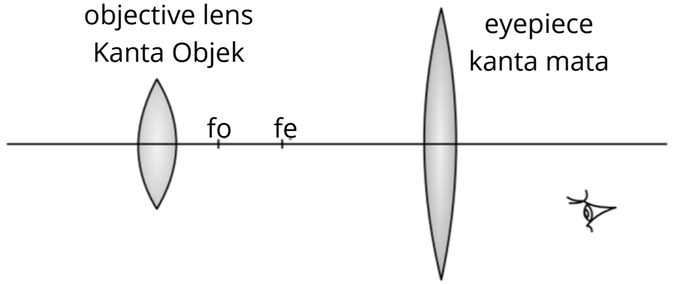
Telescope	▼ Power	L = fo + fe	▲ Power
Microscope	▲ Power	L > fo + fe	▼ Power

bigger diameter lens - more light can be refracted
Image produce : Virtual, Inverted, Magnified

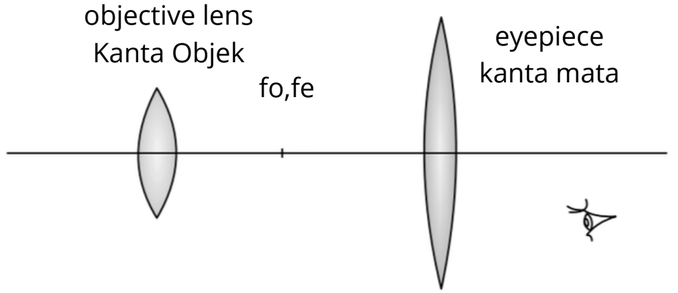


Which of the following is the correct arrangement of lenses for microscope?
Manakah susunan yang betul bagi kanta-kanta pada mikroskop?

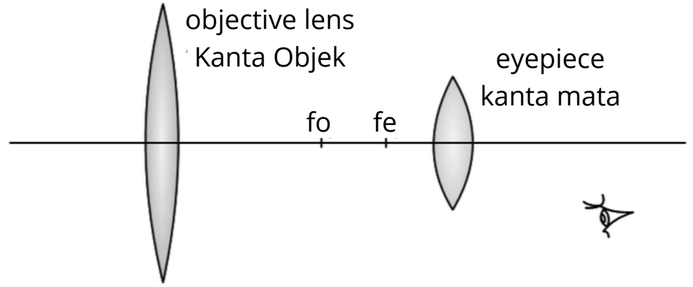
A



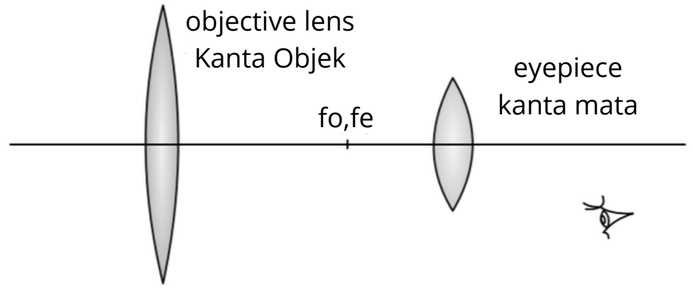
B



C



D



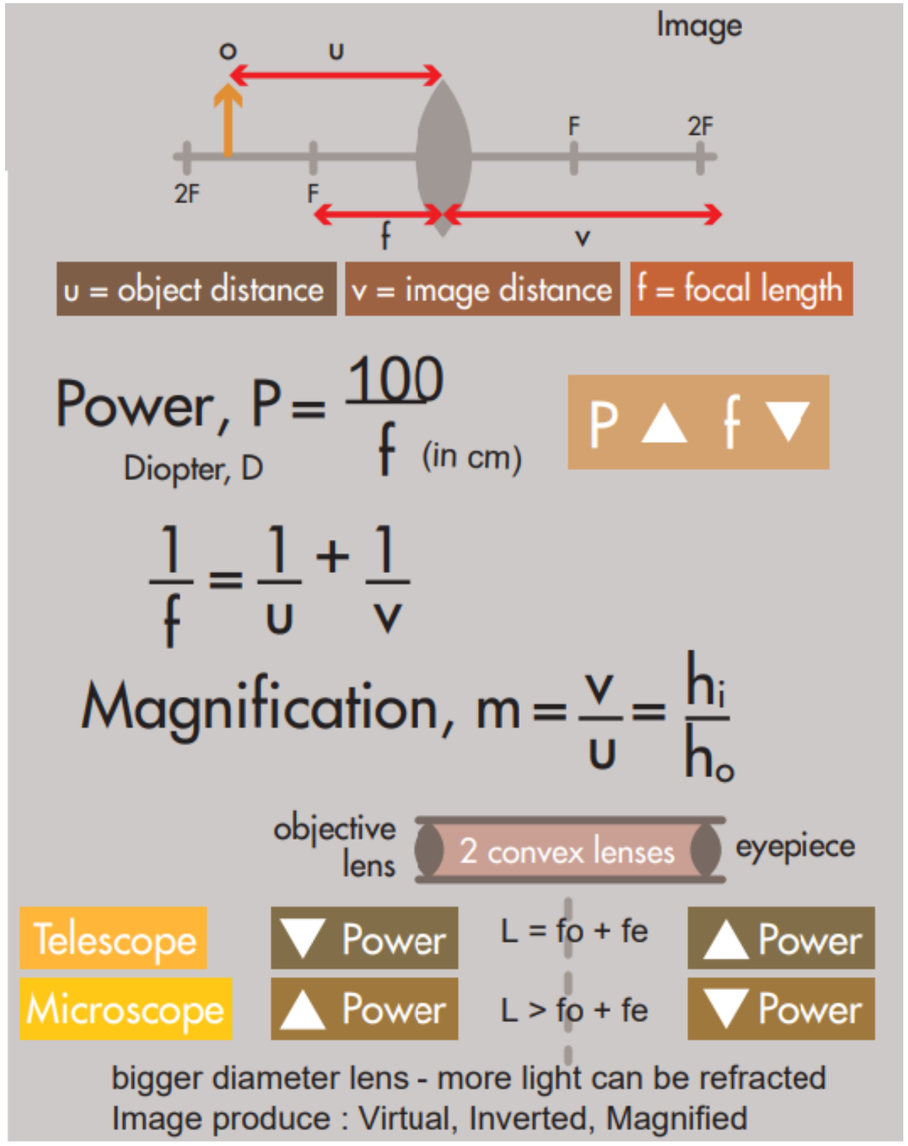
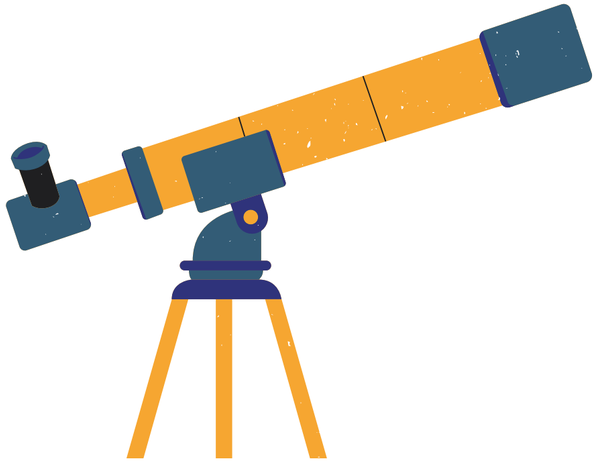


Diagram shows an astronomical telescope at normal adjustment
Rajah menunjukkan sebuah teleskop astronomi dalam pelarasan normal



What is the distance between the eyepieces and objective lens of the telescope if the power of the objective lens and eyepieces is 4D and 20 D respectively
Berapakah jarak antara kanta mata dan kanta objek bagi teleskop itu dengan kuasa kanta objek dan kanta mata ialah 4D dan 20 D.

A. 24 cm
B. 30 cm
C. 48 cm
D. 16 cm